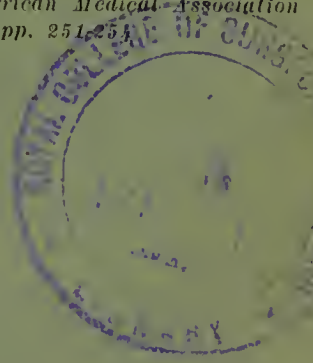


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ROBERT W. LOVETT, M.D.
BOSTON

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PRINCIPLES OF THE TREATMENT OF INFANTILE PARALYSIS

ROBERT W. LOVETT, M.D.
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The question of the treatment of infantile paralysis is in these days always before the medical profession of the United States, because each summer since 1907 has left behind it hundreds and sometimes thousands of victims, and with our added experience and our facilities for clinical observation, unfortunately far greater than anywhere else in the world, our ideas of treatment have progressed and have become more defined. If the point of view advanced in this paper is that of an orthopedic surgeon, it is because in most bad cases the surgeon or the orthopedic surgeon is sooner or later consulted, and these two from seeing end-results are perhaps best equipped to judge of the efficiency of the various forms of the earlier treatment.

EARLY DIAGNOSIS IN RELATION TO TREATMENT

The diagnosis of the disease before the appearance of paralysis is constantly overlooked. This is a cause of dissatisfaction to the family and of mortification to the physician, but probably not of great moment to the patient, for even when a correct or a provisional diagnosis is made early it is doubtful if anything can be done to influence greatly the course of the affection. Flexner's* experiments with hexamethylenamin showed that it seemed to have some immunizing effect on monkeys, but that after infection had occurred it had no effect. Still, on the supposition that monkeys and children may not be affected in just the same way, and as the drug in moderation seems to be harmless, the early use of hexamethylenamin seems our best chance. Occasionally cases occur which suggest that it may have been useful. For

* Flexner, Simon, and Clark, Paul F.: Experimental Poliomyelitis in Monkeys, *THE JOURNAL A. M. A.*, Feb. 25, 1911, p. 585.

example, in July, 1911, three children in one family were affected at intervals of three or four days with fever, prostration and gastro-intestinal disturbance. The diagnosis of the first case was made only after the second child was in the height of her attack and before the third was affected. The first child received no hexamethylenamin, the second had a little, and the third had large doses from the beginning. The first child was severely paralyzed from the waist down, the second had weakness of the legs and back for a few months, and the third had no muscular involvement. All were equally sick. Such an observation, of course, proves nothing, but in connection with the early history of other cases that I have analyzed has made me feel that the early use of hexamethylenamin is desirable in suspected cases.

TREATMENT OF THE ACUTE PHASE

Little time need be spent in discussing the general measures of rest, catharsis, light feeding and quiet, which are universally agreed on. If any criticism is to be made it is that children slightly affected are often allowed to be too active; but generally the patient is so ill at first and so tender after the attack that this matter takes care of itself.

In formulating the treatment of the acute attack and of the days following we have only to remember the pathology of the affection. It is essentially a hemorrhagic myelitis with a widely distributed accompanying meningitis. Such a condition obviously demands general quiet, freedom from excitement and activity, and recumbency for a period of days or weeks. Even in the slightest cases the lesion cannot be immediately recovered from, and the observations on monkeys have taught us that some of the muscular paralysis is due to an edema in the cord accompanying the hemorrhagic process. The need of the measures spoken of must be self-evident, and my own practice has been to secure for even the slightest cases quiet for at least two or three weeks, and for the severer cases quiet until all tenderness has disappeared.

It must be said, however, that comparison of different treatments must be made with care, for no two cases are alike, the dose of poison or the individual resistance varies enormously, and the condition in the acute attack gives no very accurate means of telling what the ultimate outcome will be, except that the general conclusion

may be formulated that on the whole very severe attacks are most often accompanied by severe paralysis and slighter attacks by more moderate and slighter forms.¹

Two hundred and thirty-four cases of paralysis occurring in Massachusetts in 1907 were investigated in 1911 by a competent orthopedic surgeon.² Seeing as many of the patients as could be traced, he found that 25 per cent. had wholly recovered without regard to whether they had or had not been treated, and, moreover, that the analysis of the early history of these cases showed them to be average cases and that they could not in the early stage have been picked as cases in which the patients were especially likely to recover.

All of this goes to confirm the statement that the outcome of the case is not wholly determined by the treatment received, a point which parents are slow to grasp.

TREATMENT OF THE TENDER CONVALESCENT PHASE

Any rigid division of the disease into stages is misleading and out of accord with facts, because one stage melts into another so gradually that a dividing line is impossible. Still there are different aspects of the affection, which have been spoken of here as phases.

Following the subsidence of fever the patient is generally paralyzed in one or more limbs, tender to the touch and on motion, somewhat prostrated, and generally shows the results of a general infection. The latter, however, is soon recovered from, although in the severer cases the patient is generally below par for some time. This is the period when spontaneous improvement will begin, and the family may be assured that improvement which they can see will occur in a few weeks. It is generally difficult to make the family and the practitioner who has not had much experience in the disease understand that the best treatment at this stage is to let the patient alone except for preventing contraction of the Achilles tendon, which may occur to a troublesome extent in the first two or three weeks.

So long as tenderness lasts it may be accepted as evidence of the existence of some degree of active myelitis around the motor and especially the sensory centers of the cord. Under these condition it seems unphysiologic to stimulate by passive movements, massage or electricity

1. Lovett, Robert W., and Lucas, W. P.: Infantile Paralysis, a Study of 635 Cases, *THE JOURNAL A. M. A.*, Nov. 14, 1908, p. 1677.
 2. Wood, B. E.: *Boston Med. and Surg. Jour.*, Oct. 5, 1911.

the peripheral parts connected with those centers. Yet the early use of these measures is a common practice.

The tenderness may last from two to three months after the attack, and a perfectly inactive treatment is hard to pursue when the family has heard of the wonders of electricity and massage, and is anxious not to lose time. But so long as the tenderness lasts, the best practice is to let the patient alone so far as active treatment goes. Frequent changes of position are desirable, and there is no objection to the sitting position for the convalescent, to outdoor air, or to immersion in a warm bath with whatever active movement under water may be accomplished without discomfort.

There is no danger that the joints will stiffen, and in the first weeks the only troublesome complication to be feared, as has been said, is contraction of the Achilles tendon. If this is occurring it is justifiable to stretch the posterior muscles gently with the hand, even at the risk of causing some discomfort, rather than to allow a permanent contraction to occur. The easiest means of preventing the contraction is from the beginning to have the soles of the feet rest against a box covered with a blanket placed against the bottom of the bed, which holds the feet at a right angle to the legs. Unless this is done the weight of the bed-clothes and the dropped position of the unsupported foot in sitting will in most cases cause some degree of talipes equinus. The frequency with which this complication is seen in practice shows that it is not an imaginary danger.

TREATMENT OF THE CONVALESCENT PHASE AFTER TENDERNESS HAS GONE

With the disappearance of tenderness the time for active treatment has begun, and the sooner the patient is put on his feet and resumes activity the better. It seems probable on general principles that in cases of any degree of severity, even if tenderness disappears earlier than four weeks, active treatment should not be begun before that time, while some authorities would forbid active measures before the expiration of six weeks from the onset. In my experience, however, I have seen nothing but good come from instituting treatment at four weeks when the disappearance of tenderness has warranted it. The general condition of the patient, moreover, must not be neglected, as many of the chil-

dren at this time have not wholly recovered from the effects of the infection, and are anemic, poorly, and easily fatigued.

The therapeutic measures at our disposal are massage, electricity and muscle training.

Massage may be expected to improve the local and general circulation, to facilitate the flow of lymph, and to retard muscular deterioration. It cannot, however, be expected to facilitate the transmission of a motor impulse from the brain to the affected or weakened muscle. In estimating its value in the treatment we must remember that it is only a part of the treatment.

Electricity is less highly regarded in the treatment than was formerly the case. The unintelligent use of electricity month after month to the exclusion of other measures has been one of the handicaps which has stood in the way of the best progress in many cases. It is quite possible that it may improve the muscular condition, and it may induce the contraction of muscles which cannot be reached otherwise, but its value has apparently been overrated, and in my own practice I have seen no convincing evidence that its use was beneficial, and I have preferred to concentrate on the measures which I could see were of distinct use.

Muscle training is apparently the most useful of the three therapeutic measures mentioned, apparently because it rests on the best physiologic basis. This is what happened before the attack, and what we want to have happen again, when the child desires to contract a certain muscle, to perform a certain motion: An impulse to move the muscle started from the motor area in the brain, and descended along the spinal cord motor-tracts to the spinal center controlling that muscle, where it was modified and distributed to the proper motor nerves and sent along them to cause muscular contraction. By the disease, certain spinal motor centers were destroyed, and can therefore no longer act to distribute motor impulses to their muscles. But such spinal centers and their connections are complicated affairs, and every muscle is connected with several centers, every center sends impulses to more than one muscle, and, moreover, the connections between the spinal centers are many. Unless, therefore, the destruction in the cord has been a very extensive one it is likely that some of the motor centers in any one region will have escaped

destruction, and that it may be possible to establish new connections around the destroyed centers. If a railway wreck occurs on the main line and the track is blocked it is often possible to send trains by means of a branch line around the obstruction, so that service between the terminals is maintained. In the same way after a wreck of certain nerve centers it may be possible by a modified route to send a motor impulse from brain to muscle. On this principle of establishing new connections and opening new paths rests most of the claim of muscle training, but not entirely on this, because on account of the local edema of the cord accompanying the infiltration and hemorrhagic process certain motor centers are temporarily put out of order but not destroyed. Muscle training aids these to recover function.

Muscle training in its most obvious form consists in aiding the patient to perform a certain movement with the hope of stimulating an impulse from the brain to the weakened or paralyzed muscles. If, for instance, the dorsal flexors of the foot do not act, through being stretched, weakened, partly paralyzed or wholly paralyzed, in the exercise the foot is dorsally flexed with the hand and the patient directed to assist. If there is any muscular response less and less aid is given to the muscle by the hand, and it may be that in this way it can be trained to perform its function. A detailed account of the exercises for the different groups of muscles has been given by Wright.³

In my personal experience the success of muscle training and other measures has been greater in the legs than in the arms.

Another and equally useful form of muscle training consists in getting the patient on his feet at the earliest possible moment in order to call forth the instinctive muscular actions induced by the efforts to walk and balance. Even before it is possible to make much progress in this way, sitting is useful for the spinal and trunk muscles.

THE USE OF APPARATUS AND BRACES

Many patients at the beginning are unable to stand without apparatus, because, for example, the knees flex on account of weakness or paralysis of the quadriceps muscle. In these cases a caliper splint should be applied

3. Wright: Muscle Training in the Treatment of Infantile Paralysis, Boston Med. and Surg. Jour., Oct. 24, 1912.

to hold the knees straight.⁴ If the feet roll in or out varus or valgus braces should be applied. If the spine or abdomen is involved, a corset or jacket should be worn. Crutches are at first necessary in cases of paralysis of both legs. In other words, if the standing position induces malposition, such malposition must be corrected, because nothing but harm can come of it.

The fear that the early use of apparatus will promote muscular atrophy is wholly unreasonable, because nothing is so bad as disuse, and braces should mean the upright position, and the upright position means more muscular activity. The best way to avoid wearing a brace permanently is to put it on early and keep it on as long as necessary. For a growing child to walk about with a malposition is to bid for a permanent deformity.

DEFORMITY

If fixed deformity exists, it must be removed before treatment of any sort can be satisfactory. By fixed deformity is meant a condition in which the functions of a joint are limited, in which its are is restricted. If a child sits with the foot dropped and it can be normally flexed by the hand to its normal extent it is merely a malposition; if it cannot be brought to a right angle it is a deformity. The difference is an important practical one.

The common and most troublesome deformities in neglected cases are fixed contractions of the feet in varus, valgus or equinus, flexion of the knees and contraction of the fascia lata, causing contraction of the thighs on the body. These deformities are easily remedied by stretching or cutting, and this is an essential preliminary to other mechanical or operative treatment. One should, however, be careful about cutting the Achilles tendon without some further operation when the anterior leg muscles are paralyzed, as an unsatisfactory limp and powerless foot may result.

The most troublesome deformity of all is lateral curvature of the spine, which occurs to some degree in most cases in which the shoulder, back or respiratory muscles are involved, which should always be watched for. Many errors would be avoided if every child with infantile paralysis were stripped and examined for scoliosis. It

4. Methods of Treatment in Infantile Paralysis, Department of Orthopedic Surgery, Harvard Medical School, Boston Med. and Surg. Jour., June 30, 1910.

is singularly resistant to treatment, and when it affects the cervicodorsal region is practically not to be controlled. Lower down in the spine it may be greatly benefited by proper jackets and exercises. But such jackets must be applied early and worn persistently, because the cause, the unilateral muscular paralysis, is always present to aggravate the condition.

OPERATIVE TREATMENT

It is my purpose in this paper to give only the briefest possible outline of operative treatment. Operations are undertaken:

1. To correct fixed deformity.
2. To improve muscular function.
3. To secure stability of useless joints.

1. The correction of fixed deformity has already been dealt with.

2. The improvement of muscular function is accomplished by the transference of the tendinous end of a sound muscle to the place of insertion of a paralyzed muscle, so that its function is substituted for the lost function. The operation is useful in carefully selected cases, and must rest on careful anatomic study. The technic is of great importance, and has been fully discussed.⁵

The operation should not be performed until two or three years after the acute attack, and is not suitable for very young children. The passage of a considerable length of time since the attack is not a barrier to operation, and it is useful in adults.

The most important recent additions to our knowledge are that insertion into bone or periosteum (preferably the former) is preferable to insertion into tendons, and that silk elongation of the tendon may be performed with impunity and makes the operation much more widely applicable. Good function in the operated limb cannot be expected under six months.

3. The stability of flail and useless joints may be secured in several ways.

Arthrodesis, or the production of artificial ankylosis, in such a joint is obtained by opening the joint and removing the articular cartilage. In the ankle it has

5. Lange, F.: *The Orthopedic Treatment of Infantile Paralysis*, Am. Jour. Orthop. Surg., August, 1910; *Ergebnisse der Chirurgie und Pathologie*, Payr and Küttner, Berlin, 1911, II, 1.

been most used, and under proper conditions furnishes a stiff ankle so that the patient need not wear a brace. It is, however, not to be done unreservedly. There is no use in stiffening an ankle unless the knee is good and can bear weight, and it is not to be done in children under 12, or a serious deformity may follow, incident to the growth of the foot, which may cause a bad varus. Arthrodesis of the knee should never be attempted in children on account of the danger of interfering with epiphyseal growth, and most adults prefer a brace which can be unlocked for bending when sitting down, to a permanently stiff leg. At the hip it is an operation little used, and chiefly to be considered when the hip is dislocated and can be reduced. In the shoulder it is sometimes useful.

Silk ligaments at the anterior aspect of the ankle are much to be preferred to arthrodesis in cases of flail ankle, because they do not cause a stiff joint, but allow dorsal flexion while they check plantar flexion or dropping of the foot; they do not cause bony distortion, and they may be safely used in middle childhood. Just as the silk elongation of a muscle is coated with fibrous tissue and becomes a tendon, so does silk inserted to check joint motion become coated with fibrous tissue to form a ligament.

In the technic one or two matters are of much importance. The crest of the tibia above the ankle is exposed, periosteum incised and turned back, and a hole drilled in the bone. One of the bones in the tarsus at the inner or outer side of the foot, or both, as the indication for support determines, is drilled in the same way, and one or two strands of heavy silk are passed through the tibial hole under the annular ligament, through the tarsal hole, and tied. The knot must come in the upper wound, as otherwise it is likely to chafe through from pressure of the boot. At least three months' support is necessary, and probably more.

The application of silk ligaments to other joints has not been fully worked out. In my own practice I have not done an arthrodesis of the ankle for dropped foot for several years, because the results of the silk ligament operation are so much more satisfactory. Other operations for fixation are advocated.⁶

6. Putti: *Bull. d. Sc. Méd.*, lxxxiii, Series 8, 1912, xli. Bartow and Plummer: *Buffalo Med. Jour.*, January, 1912.

In cases of paralytic calcaneus deformity, the Whitman operation⁷ consists in removing the astragalus and setting the foot back in relation to the leg. After the operation the foot should be placed in the equinus position.

CONCLUSION

The foregoing seems to me to be a summary of the modern treatment of infantile paralysis, colored of course by my own personal experience. I think that those of us who live in communities which have been severely affected become every year more hopeful and more persistent in our efforts. There seems no time limit as to improvement, and many of the most neglected cases seem the most striking when they come to proper treatment. I have merely tried to show that a treatment based on our more recent knowledge of the disease differs in some respects from our former ideas, which were based on smaller experience and a less exact pathology.

234 Marlborough Street.

7. Whitman: Treatise on Orthopedic Surgery, ed. 4, Lea and Febiger, Philadelphia.